PERMITTED POINT DELETIONS FROM REGRESSION ANALYSIS

Condition	Points to be deleted
1. Wide Open Throttle and Torque Feedback < Torque Reference	Torque, and/or BHP.
2. Closed Throttle, Not an Idle Point, Torque Feedback >Torque Reference	Torque, and/or BHP.
3. Closed Throttle, Idle Point, and Torque Feedback = CITT (10 ft-lb)	Speed, and/or BHP.

For the purposes of this discussion:

An Idle Point is defined as a point having a Normalized Reference Torque of 0 and a Normalized Reference Speed of 0 and an engine tested as having a manual transmission has a CITT of 0. Point deletion may be applied either to the whole or to any part of the cycle. EXPSTB='00'

(4)(i) For petroleum-fueled and methanol-fueled diesel engines, the integrated brake horsepower-hour for each cycle (cold and hot start) shall be between −15 percent and +5 percent of the integrated brake horsepower-hour for the reference cycle, or the test is void.

(ii) For gasoline-fueled and methanol-fueled Otto-cycle engines, the integrated brake horsepower-hour of the feedback cycle shall be within 5 percent of the integrated brake horsepower-hour of the reference cycle for the cold cycle, or the test is void. The tolerance for the hot cycle shall be 4 percent.

(5) If a dynamometer test run is determined to be statistically or experimentally void, corrective action shall be taken. The engine shall then be allowed to cool (naturally or forced) and the dynamometer test rerun per §86.1337 or be restarted at §86.1336–84(e).

(d) For petroleum-fueled and methanol-fueled diesel engines, all reference torque values specified (in paragraph (f)(2) of appendix I to this part) as "closed throttle" shall be deleted from the calculation of cycle torque and power validation statistics.

[54 FR 14604, Apr. 11, 1989, as amended at 62 FR 47134, Sept. 5, 1997]

§86.1341–98 Test cycle validation criteria.

Section 86.1341–98 includes text that specifies requirements that differ from §86.1341–90. Where a paragraph in §86.1341–90 is identical and applicable to §86.1341–98, this may be indicated by specifying the corresponding paragraph and the statement "[Reserved]. For guidance see §86.1341–90"

(a) Through (b)(2) [Reserved]. For guidance see §86.1341–90.

(b)(3) All feedback torques due to accessory loads, either actual or simulated as defined in §86.1327–90 (d)(4), shall be excluded from both cycle validation and the integrated work used for emissions calculations.

(4) For reference idle portions of the cycle where CITT is not applied, use measured torque values for cycle validation and the reference torque values for calculating the brake horsepower-hour value used in the emission calculations. For reference idle portions of the cycle where CITT is applied, use measured torque values for cycle validation and calculating the brake horsepower-hour value used in the emission calculations.

(c) Through (d) [Reserved]. For guidance see §86.1341–90.

[62 FR 47135, Sept. 5, 1997]

§86.1342–90 Calculations; exhaust emissions.

(a) The final reported transient emission test results should be computed by using the following formula:

$$A_{WM} = \frac{(1/7)\big(g_C\big) + (6/7)\big(g_H\big)}{(1/7)\big(BHP - hr_C\big) + (6/7)\big(BHP - hr_H\big)}$$

Where:

(1) A_{WM} = Weighted mass emission level (HC, CO, CO_2, or NO_X) in grams per brake horsepower-hour and, if appropriate, the weighted mass total hydrocarbon equivalent, in grams per brake horsepower-hour.

(2) g_C = Mass emission level in grams or grams carbon mass equivalent, measured during the cold start test.

(3) g_H = Mass emission level in grams or grams carbon mass equivalent, measured during the hot start test.

(4) BHP − hr_C = Total brake horsepower-hour (brake horsepower integrated over time) for the cold start test.

(5) BHP–hr_H = Total brake horsepower-hour (brake horsepower integrated over time) for the hot start test.

(b) The mass of each pollutant for the cold start test and the hot start test for bag measurements and diesel continuously heated sampling system measurements is determined from the following equations:

(1) Hydrocarbon mass:

$$HC_{mass} = V_{mix} \times Density_{HC} \times (HC_{conc}/10^6)$$

(2) Oxides of nitrogen mass:

$$NOx_{mass} = V_{mix} \times Density_{NO2} \times K_H \times (NOx_{conc}/10^6)$$

(3) Carbon monoxide mass:

$$CO_{mass} = V_{mix} \times Density_{CO} \times (CO_{conc}/10^6)$$

(4) Carbon dioxide mass:

$$CO_{2mass} = V_{mix} \times Density\ CO_2 \times (CO_{2conc}/10^2)$$

(5) Methanol mass:

$$CH3OH_{mass} = V_{mix} \times Density\ _{CH3OH} \times (CH3OH_{conc}/10^6)$$

(6) Formaldehyde mass:

$$HCHO_{mass} = V_{mix} \times Density_{HCHO} \times (HCHO_{conc}/10^6)$$

(7) Total hydrocarbon equivalent mass:

(i)

$$THCE = HC_{mass} + \frac{13.8756}{32.042}\left(CH_3OH_{mass}\right) + \frac{13.8756}{30.0262}\left(HCHO_{mass}\right)$$

(c) The mass of each pollutant for the cold start test and the hot start test for flow compensated sample systems is determined from the following equations:

$$(1) \quad HC_{mass} = \sum_{i=1}^{n} \left[\frac{(HC_e)_i}{10^6} \times (V_{mix})_i \times (Density_{HC}) \times \Delta T \right]$$

$$- \frac{HC_d}{10^6} \left(1 - \frac{1}{DF}\right) \times V_{mix} \times Density_{HC}$$

$$(2) \quad NOx_{mass} = K_H \times \sum_{i=1}^{n} \left[\frac{(NOx_e)_i}{10^6} \times (V_{mix})_i \times (Density_{NO_2}) \times \Delta T \right]$$

$$- K_H \times \frac{NOx_d}{10^6} \left(1 - \frac{1}{DF}\right) \times V_{mix} \times Density_{NO_2}$$

$$(3) \quad CO_{mass} = \sum_{i=1}^{n} \left[\frac{(CO_e)_i}{10^6} \times (V_{mix})_i \times (Density_{CO}) \times \Delta T \right]$$

$$- \frac{CO_d}{10^6} \left(1 - \frac{1}{DF}\right) \times V_{mix} \times Density_{CO}$$

$$(4) \quad CO2_{mass} = \sum_{i=1}^{n} \left[\frac{(CO_{2e})_i}{10^6} \times (V_{mix})_i \times (Density_{CO_2}) \times \Delta T \right]$$

$$- \frac{CO_{2d}}{10^6} \left(1 - \frac{1}{DF}\right) \times V_{mix} \times Density_{CO_2}$$

(d) Meaning of symbols:

(1)(i) HC_{mass} = Hydrocarbon emissions, in grams per test phase.

(ii) $Density_{HC}$ = Density of hydrocarbons = 16.33 g/ft³ (0.5768 kg/m³) for gasoline and the gasoline fraction of methanol-fuel, and may be used for petroleum and the petroleum fraction of methanol diesel fuel if desired, 16.42 g/ft³ (0.5800 kg/m³) for #1 petroleum diesel fuel and 16.27 g/ft³ (0.5746 kg/m³) for #2 diesel, assuming an average carbon to hydrogen ratio of 1:1.85 for gasoline, 1:1.93 for #1 petroleum diesel fuel and 1:1.80 for #2 petroleum diesel fuel at 68 °F (20 °C) and 760 mm Hg (101.3 kPa) pressure.

(iii)(A) HC_{conc} = Hydrocarbon concentration of the dilute exhaust sample corrected for background, in ppm carbon equivalent (i.e., equivalent propane × 3).

(B) $HC_{conc} = HC_e - HC_d(1 - (1/DF))$

Where:

(iv)(A) HC_e = Hydrocarbon concentration of the dilute exhaust bag sample or, for diesel continuous heated sampling systems, average hydrocarbon concentration of the dilute exhaust

sample as determined from the integrated HC traces, in ppm carbon equivalent. For flow compensated systems $(HC_e)_i$ is the instantaneous concentration.

(B) For petroleum-fueled engines, HC_e is the FID measurement.

(C) For methanol-fueled engines:

$HC_e = FID\ HC_e - (r)C_{CH3OHe}$

(v) FID HC_e = Concentration of hydrocarbon plus methanol in dilute exhaust as measured by the FID, ppm carbon equivalent.

(vi) r = FID response to methanol.

(vii) C_{CH3OHe} = Concentration of methanol in dilute exhaust as determined from the dilute exhaust methanol sample, ppm carbon.

(viii)(A) HC_d = Hydrocarbon concentration of the dilution air as measured, in ppm carbon equivalent.

(B) $HC_d = FID\ HC_d - (r)C_{CH3OHd}$

(ix) FID HC_d = Concentration of hydrocarbon plus methanol in dilution air as measured by the FID, ppm carbon equivalent.

(x) C_{CH3OHd} = Concentration of methanol in dilution air as determined from dilution air methanol sample in ppm carbon.

(2)(i) NOx_{mass} = Oxides of nitrogen emissions, in grams per test phase.

(ii) $Density_{NO2}$ = Density of oxides of nitrogen is 54.16 g/ft^3 (1.913 kg/m^3), assuming they are in the form of nitrogen dioxide, at 68 °F (20 °C) and 760 mm Hg (101.3 kPa) pressure.

(iii)(A) NOx_{conc} = Oxides of nitrogen concentration of the dilute exhaust sample corrected for background, in ppm.

(B) $NOx_{conc} = NOx_e - NOx_d\ [1 - (1/DF)]$

Where:

(iv) NOx_e = Oxides of nitrogen concentration of the dilute exhaust bag sample as measured, in ppm. For flow compensated sample systems $(NOx_e)_i$ is the instantaneous concentration.

(v) NOx_d = Oxides of nitrogen concentration of the dilution air as measured, in ppm.

(3)(i) CO_{mass} = Carbon monoxide emissions, grams per test phase.

(ii) $Density_{CO}$ = Density of carbon monoxide is 32.97 g/ft^3 (1.164 kg/m^3), at 68 °F (20 °C) and 760 mm Hg (101.3 kPa) pressure.

(iii)(A) CO_{conc} = Carbon monoxide concentration of the dilute exhaust sample corrected for background, water vapor, and CO_2 extraction, ppm.

(B) $CO_{conc} = CO_e - CO_d[1 - (1/DF)]$

Where:

(iv) CO_e = Carbon monoxide concentration of the dilute exhaust bag sample volume corrected for water vapor and carbon dioxide extraction, in ppm. For flow compensated sample systems $(CO_e)_i$ is the instantaneous concentration.

(v)(A) $CO_e = (1 - 0.01925CO_{2e} - 0.000323R)CO_{em}$ for gasoline and petroleum diesel fuel, with hydrogen to carbon ratio of 1.85:1.

(B) $CO_e = [1 - (0.01 + 0.005HCR)\ CO_{2e} - 0.000323R]\ CO_{em}$ for methanol fuel, where HCR is hydrogen to carbon ratio as measured for the fuel used.

Where:

(vi) CO_{em} = Carbon monoxide concentration of the dilute exhaust sample as measured, in ppm.

(vii)(A) CO_{2e} = Carbon dioxide concentration of the dilute exhaust bag sample, in percent, if measured. For flow compensated sample systems, $(CO_{2e})_i$ is the instantaneous concentration. For cases where exhaust sampling of CO_2 is not performed, the following approximation is permitted:

(B)

$$CO_{2e} = \frac{44.010}{12.011 + (1.008\alpha)} \times \frac{M'(453.6)}{Density\ CO_2} \times \frac{100}{V_{mix}}$$

Where:

(C) α = Average carbon to hydrogen ratio, as specified by the Administrator.

(D) M′ = Fuel mass consumed during the test cycle.

(E) R = Relative humidity of the dilution air, percent.

(viii)(A) CO_d = Carbon monoxide concentration of the dilution air corrected for water vapor extraction, in ppm.

(B) $CO_d = (1 - 0.000323R)CO_{dm}$.

Where:

(ix) CO_{dm} = Carbon monoxide concentration of the dilution air sample as measured, in ppm.

NOTE: If a CO instrument which meets the criteria specified in §86.1311 is used and the conditioning column has been deleted, CO_{em} must be substituted directly for CO_e, and CO_{dm} must be substituted directly for CO_d.

(4)(i) CO_{2mass} = Carbon dioxide emissions, in grams per test phase.

(ii) Density CO_2 = Density of carbon dioxide is 51.81 g/ft³ (1.830 kg/m³), at 68 °F (20 °C) and 760 mm Hg (101.3 kPa) pressure.

(iii) CO_{2conc} = Carbon dioxide concentration of the dilute exhaust sample corrected for background, in percent.

(iv) $CO_{2mass} = CO_{2e} - CO_{2d}[1 - (1/DF)]$.

Where:

(v) CO_{2d} = Carbon dioxide concentration of the dilution air as measured, in percent.

(5)(i) CH_3OH_{mass} = Methanol emissions corrected for background, in grams per test phase.

(ii) Density$_{CH3OH}$ = Density of methanol is 37.71 g/ft³ (1.332 kg/m³), at 68 °F (20 °C) and 760 mm Hg (101.3kPa) pressure.

(iii)(A) CH_3OH_{conc} = Methanol concentration of the dilute exhaust corrected for background, in ppm.

(B) $CH_3OH_{conc} = C_{CH3OHe} - C_{CH3OHd} [1 - (1/DF)]$.

Where:

(iv)(A) C_{CH3OHe} = Methanol concentration in the dilute exhaust, in ppm.

(B)

$$C_{CH3OHe} \frac{3.813 \times 10^{-2} \times C_{CH3OHR} \times T_{EM}\left[(A_{S1} \times AV_{S1}) + (A_{S2} \times AV_{S2})\right]}{A_{CH3OHR} \times P_B \times V_{EM}}$$

(v)(A) C_{CH3OHd} = Methanol concentration in the dilution air, in ppm.

(B)

$$C_{CH3OHd} \frac{3.813 \times 10^{-2} \times C_{CH3OHR} \times T_{DM}\left[(A_{D1} \times AV_{D1}) + (A_{D2} \times AV_{D2})\right]}{A_{CH3OHR} \times P_B \times V_{DM}}$$

(vi) C_{CH3OHR} = Concentration of methanol in standard sample for calibration of GC, µg/ml.

(vii) A_{CH3OHR} = GC peak area of standard sample.

(viii) T_{EM} = Temperature of methanol sample withdrawn from dilute exhaust, °R.

(ix) T_{DM} = Temperature of methanol sample withdrawn from dilution air, °R.

(x) P_B = Barometric pressure during test, mm Hg.

(xi) V_{EM} = Volume of methanol sample withdrawn from dilute exhaust, ft³.

(xii) V_{DM} = Volume of methanol sample withdrawn from dilution air, ft³.

(xiii) A_S = GC peak area of sample drawn from dilute exhaust.

(xiv) A_D = GC peak area of sample drawn from dilution air.

(xv) AV_S = Volume of absorbing reagent (deionized water) in impinger through which methanol sample from dilute exhaust is drawn, ml.

(xvi) AV_D = Volume of absorbing reagent (deionized water) in impinger through which methanol sample from dilution air is drawn, ml.

(xvii) 1 = first impinger.

(xviii) 2 = second impinger.

(6)(i) $HCHO_{mass}$ = Formaldehyde emissions corrected for background, grams per test phase.

(ii) Density$_{HCHO}$ = Density of formaldehyde is 35.36 g/ft³ (1.249 kg/m³), at 68 °F (20 °C) and 760 mmHg (101.3 kPa) pressure.

(iii)(A) $HCHO_{conc}$ = Formaldehyde concentration of the dilute exhaust corrected for background, ppm.

(B) $HCHO_{conc} = C_{HCHOe} - C_{HCHOd} [1 - (1/DF)]$.

Where:

(iv)(A) C_{HCHOe} = Formaldehyde concentration in dilute exhaust, ppm.

(B)

$$C_{HCHOe} = \frac{4.069 \times 10^{-2} \times C_{FDE} \times V_{AE} \times Q \times T_{EF}}{V_{SE} \times P_B}$$

(v)(A) C_{HCHOd} = Formaldehyde concentration in dilution air, ppm.

$$C_{HCHOd} = \frac{4.069 \times 10^{-2} \times C_{FDE} \times V_{AA} \times Q \times T_{DF}}{V_{SA} \times P_B}$$

(vi) C_{FDE} = Concentration of DNPH derivative of formaldehyde from dilute exhaust sample in sampling solution, µg/ml.

(vii) V_{AE} = Volume of sampling solution for dilute exhaust formaldehyde sample, ml.

(viii)(A) Q = Ratio of molecular weights of formaldehyde to its DNPH derivative.

(B) Q = 0.1429.

(ix) T_{EF} = Temperature of formaldehyde sample withdrawn from dilute exhaust, °R.

(x) V_{SE} = Volume of formaldehyde sample withdrawn from dilute exhaust, ft³.

(xi) P_B = Barometric pressure during test, mm Hg.

(xii) C_{FDA} = Concentration of DNPH derivative of formaldehyde from dilution air sample in sampling solution, µg/ml.

(xiii) V_{AA} = Volume of sampling solution for dilution air formaldehyde sample, ml.

(xiv) T_{DF} = Temperature of formaldehyde sample withdrawn from dilution air, °R.

(xv) V_{SA} = Volume of formaldehyde sample withdrawn from dilution air, ft³.

(7)(i) $DF = 13.4/[CO_{2e} + (HC_e + CO_e)10^{-4}]$ for petroleum-fueled vehicles, or $DF = 13.4/CO_{2e}$

$$(ii)\ DF = \frac{100 \times \left(\dfrac{x}{x + y/2 + 3.76(x + y/4 - z/2)} \right)}{CO_{2e} + \left(HC_e + CO_e + CH_3OH_e \right)10^{-4}}$$

for methanol-fueled vehicles, where fuel composition is $C_X H_y O_z$ as measured for the fuel used.

(8)(i) K_H = Humidity correction factor.

(ii) For gasoline-fueled and methanol-fueled diesel engines: $K_H = 1/[1 - 0.0047 (H - 75)]$ (or for SI units, $K_H = 1/[1 - 0.0329(H - 10.71)]$).

(iii) For petroleum-fueled and methanol-fueled diesel engines: $K_H = 1/[1 - 0.0026 (H - 75)]$ (or for SI units = $1/[1 - 0.0182 (H - 10.71)]$).

Where:

(iv)(A) H = Absolute humidity of the engine intake air in grains (grams) of water per pound (kilogram) of dry air.

(B)(*1*) $H = [(43.478)R_i \times P_d]/[P_B - (P_d \times R_i/100)]$

(*2*) *For SI units,*

$H = [(6.211)R_i \times P_d]/[P_B - (P_d \times R_i/100)]$

(C) R_i = Relative humidity of the engine intake air, percent.

(D) P_d = Saturated vapor pressure, in mm Hg (kPa) at the engine intake air dry bulb temperature.

(E) P_B = Barometric pressure, in mm Hg (kPa).

(9)(i) V_{mix} = Total dilute exhaust volume in cubic feet per test phase corrected to standard conditions (528 °R) (293 °K) and 760 mm Hg (101.3 kPa).

(ii) $(V_{mix})_i$ = Instantaneous dilute exhaust volumetric flow rate (for compensated flow systems), ft³/sec.

(iii) T = Time interval (seconds) between samples in flow compensated systems.

(iv) T = Total sampling time (seconds).

(v) *For PDP–CVS:*

(A)

$$V_{mix} = V_o \times \left(\frac{N(P_B - P_4)(528)}{(760)(T_p)} \right)$$

(B) *For SI units,*

$$V_{mix} = V_o \times \left(\frac{N(P_B - P_4)(293)}{(101.3)(T_p)} \right)$$

Where:

(vi) V_o = Volume of gas pumped by the positive displacement pump, in cubic feet (cubic meters) per revolution. This volume is dependent on the pressure differential across the positive displacement pump.

(vii) N = Number of revolutions of the positive displacement pump during the test phase while samples are being collected.

(viii) P_B = Barometric pressure, mm Hg (kPa).

(ix) P_4 = Pressure depression below atmospheric measured at the inlet to the positive displacement pump, in mm Hg (kPa) (during an idle mode).

(x) T_p = Average temperature of dilute exhaust entering positive displacement pump during test, °R (°K).

(e) Sample calculation of mass values of exhaust emissions:

(1) Assume the following test results for a gasoline engine:

	Cold start cycle test results	Hot start cycle test results
V_{mix}	6924 ft³	6873 ft³.
R	30.2 percent	30.2 percent.
R_i	30.2 percent	30.2 percent.
P_B	735 mm Hg	735 mm Hg.
P_d	22.676 mm Hg	22.676 mm Hg.
HC_e	132.07 ppm C equiv	86.13 ppm C equiv.
NO_{xe}	7.86 ppm	10.98 ppm.
CO_{em}	171.22 ppm	114.28 ppm.
CO_{2e}	0.178 percent	0.381 percent.
HC_d	3.60 ppm C equiv	8.70 ppm C equiv.
NO_d	0.0 ppm	0.10 ppm.
CO_{dm}	0.89 ppm	0.89 ppm.
CO_{2d}	0.0 percent	0.038 percent.
BHP–hr	0.259	0.347.

Then:

(2) *Cold Start Test:*

(i) $H = [(43.478)(30.2)(22.676)]/[735 - (22.676)(30.2)/100]$
= 41 grains of water per pound of dry air.

(ii) $K_H = 1/[1 - 0.0047(41-75)] = 0.862$

(iii) $CO_e = [1 - 0.01925(.178) - 0.000323(30.2)]171.22$
= 169.0 ppm

(iv) $CO_d = [1 - 0.000323(30.2)] 0.89 = 0.881$ ppm

(v) $DF = 13.4/[.178 + (132.07 + 169.0)(10^{-4})]$
= 64.390

(vi) $HC_{conc} = 132.07 - 3.6[1 - (1/64.390)]$
= 128.5 ppm

(vii) $HC_{mass} = 6924(16.33)(128.5/10^6)$
= 14.53 grams

(viii) $NOx_{conc} = 7.86 - 0.0[1 - (1/64.390)]$
= 7.86 ppm

(ix) $NOx_{mass} = 6924(54.16)(.862)(7.86/10^6)$
= 2.54 grams

(x) $CO_{conc} = 169.0 - .881[1 - (1/64.390)]$
= 168.0 ppm

(xi) $CO_{mass} = 6924(32.97)(168.0/10^6)$
= 38.35 grams

(xii) $CO_{2conc} = .178 - 0[1 - 1/64.390)] = 0.178\%$

(xiii) $CO_{2mass} = 6924(51.81)(.178/100) = 639$ grams

(3) *Hot start test:* Similar calculations result in the following:

(i) $HC_{mass} = 8.72$ grams

(ii) $NOx_{mass} = 3.49$ grams

(iii) $CO_{mass} = 25.70$ grams

(iv) $CO_{2mass} = 1226$ grams

(4) Weighted mass emission results:

(i) $HC_{wm} = 1/7(14.53) + 6/7(8.72)/1/7(0.259) + 6/7(0.347) = 28.6$ grams/$BHP-hr$

(ii) $NOx_{wm} = 1/7(2.54) + 6/7(3.49)/1/7(0.259) + 6/7(0.347) = 10.0$ grams/$BHP-hr$

(iii) $CO_{wm} = 1/7(38.35) + 6/7(25.70)/1/7(0.259) + 6/7(0.347) = 82.2$ grams/$BHP-hr$

(iv) $CO_{2wm} = 1/7(639) + 6/7(1226)/1/7(0.259) + 6/7(0.347) = 3415$ grams/$BHP-hr$

(f) The final reported brake-specific fuel consumption (BSFC) shall be computed by use of the following formula:

$$ BSFC = \frac{1/7(M_C) + 6/7(M_H)}{1/7(BHP-hr_C) + 6/7(BHP-hr_H)} $$

Where:

(iii) HC_{mass} = Hydrocarbon emissions, in grams, for cold or hot start test.

(iv) CO_{mass} = Carbon monoxide emissions, in grams, for cold or hot start test.

(v) CO_{2mass} = Carbon dioxide emissions, in grams, for cold or hot start test.

(vi) α = The atomic hydrogen to carbon ratio of the fuel.

(vii)(A) R_2 = The grams of carbon in the fuel per gram of fuel.

(B) $R_2 = 12.011/[12.011 + \alpha(1.008)]$

(h) Sample calculation of brake-specific fuel consumption:

(1) Assume the following test results:

	Cold start cycle test results	Hot start cycle test results
BHP-hr	6.945	7.078
α	1.85	1.85
HC_{mass} (grams)	37.08	28.82
CO_{mass} (grams)	357.69	350.33

(1) BSFC = brake-specific fuel consumption in pounds of fuel per brake horsepower-hour (lbs/BHP–hr).

(2) M_C = mass of fuel, in lbs, used by the engine during the cold start test.

(3) M_H = mass of fuel, in lbs, used by the engine during the hot start test.

(4) $BHP-hr_C$ = total brake horsepower-hours (brake horsepower integrated with respect to time) for the cold start test.

(5) $BHP-hr_H$ = total brake horsepower-hours (brake horsepower integrated with respect to time) for the hot start test.

(g)(1) The mass of fuel for the cold start and hot start test is determined from mass fuel flow measurements made during the tests, or from the following equation:

$M = (G_s/R_2)(1/453.6)$

(2) Meaning of symbols:

(i) M = Mass of fuel, in lbs, used by the engine during the cold or hot start test.

(ii) G_s = Grams of carbon measured during the cold or hot start test:

$$ G_s = \left[\frac{12.011}{12.011 + \alpha(1.008)} \right] HC_{mass} + 0.429 CO_{mass} + 0.273 CO_{2mass} $$

	Cold start cycle test results	Hot start cycle test results
CO_{2mass} (grams)	5,419.62	5,361.32

Then:

(i) G_s for cold start test = [12.011/(12.011 + (1.008)(1.85))](37.08) + 0.429(357.69) + 0.273(5419.62) = 1665.10 grams

(ii) G_s for hot start test = [12.011/(12.011 + (1.008)(1.85))](28.82) + 0.429(350.33) + 0.273(5361.32) = 1638.88 grams

(iii) R_2 = 12.011/[12.011 + (1.008)1.85] = 0.866

(iv)(A) M_c = (1665.10/.866)(1/453.6) = 4.24 lbs (calculated), or

(B)   = 4.24 lbs (directly measured).

(v)(A) M_H = (1638.88/.866)(1/453.6) = 4.17 lbs (calculated), or

(B)   = 4.17 lbs (directly measured).

(2) Brake-specific fuel consumption results:

BSFC + $(1/7)(4.24)$ = $(6/7)(4.17)/(1/7)(6.945)$ + $(6/7)(7.078)$ = 0.592 lbs of fuel/BHP−hr

(i) For dilute sampling systems which require conversion of as-measured dry concentrations to wet concentrations, the following equation shall be used for any combination of bagged, continuous, or fuel mass-approximated sample measurements (except for CO measurements made through conditioning columns, as explained in paragraph (d)(3) of this section):

Wet concentration=K_w×dry concentration.

Where:

(1)(i) For English units,

$K_w = 1 − (\alpha/200) \times CO_{2e}(') − ((1.608 \times H)/(7000 + 1.608 \times H))$

See paragraph (d)(1) of this section for α values.

(ii) For SI units,

$K_w = 1 − (\alpha/200) \times CO_{2e}(') − ((1.608 \times H)/(1000 + 1.608 \times H))$

See paragraph (d)(1) of this section for α values.

(2) $CO_{2e}(')$=either CO_{2e} or CO_{2e}' as applicable.

(3)(i) H = Absolute humidity of the CVS dilution air, in grains (grams) of water per lb (kg) of dry air.

(ii) For English units,

$H' = [(43.478)R_i' \times P_d']/[P_B − (P_d' \times R_i'/100)]$

(iii) For SI units,

$H' = [(6.211)R_i' \times P_d']/[P_B − (P_d' \times R_i'/100)]$

(4) R_i = Relative humidity of the CVS dilution air, in percent.

(5) P_d = Saturated vapor pressure, in mm Hg (kPa) at the ambient dry bulb temperature of the CVS dilution air.

(6) P_B = Barometric pressure, mm Hg (kPa).

[54 FR 14605, Apr. 11, 1989, as amended at 62 FR 47135, Sept. 5, 1997]

§86.1342–94 Calculations; exhaust emissions.

Section 86.1342–94 includes text that specifies requirements that differ from §86.1342–90. Where a paragraph in §86.1342–90 is identical and applicable to §86.1342–94, this may be indicated by specifying the corresponding paragraph and the statement "[Reserved]. For guidance see §86.1342–90."

(a) introductory text [Reserved]. For guidance see §86.1342–90.

(a)(1) A_{WM}=Weighted mass emission level (HC, CO, CO_2, or NO_X) in grams per brake horsepower-hour and, if appropriate, the weighted mass total hydrocarbon equivalent, formaldehyde, or non-methane hydrocarbon emission level in grams per brake horsepower-hour.

(a)(2) through (b)(7) [Reserved]. For guidance see §86.1342–90.

(b)(8) Non-methane hydrocarbon mass:

$NMHC_{mass} = V_{mix} \times Density_{NMHC} \times (NMHC_{conc}/1{,}000{,}000)$

(c) through (d)(1)(i) [Reserved]. For guidance see §86.1342–90.

(d)(1)(ii) $Density_{HC}$ = Density of hydrocarbons.

(A) For gasoline and the gasoline fraction of methanol-fuel, and may be used for petroleum and the petroleum fraction of methanol diesel fuel if desired; 16.33 g/ft³-carbon atom (0.5768 kg/m³-carbon atom).

(B) For #1 petroleum diesel fuel; 16.42 g/ft³-carbon atom (0.5800 kg/m³-carbon atom).

(C) For #2 diesel 16.27 g/ft³-carbon atom (0.5746 kg/m³-carbon atom). Average carbon to hydrogen ratios of 1:1.85 for gasoline, 1:1.93 for #1 petroleum diesel fuel and 1:1.80 for #2 petroleum diesel fuel are assumed at 68 °F (20 °C) and 760 mm Hg (101.3 kPa) pressure.

(D) For natural gas and liquified petroleum gas-fuel; 1.1771 (12.011+H/C (1.008)) g/ft³-carbon atom (0.04157 (12.011+H/C (1.008)) kg/m³-carbon atom) where H/C is hydrogen to carbon ratio of the hydrocarbon components of the test fuel, at 68 °F (20 °C) and 760 mm Hg (101.3 kPa) pressure.

(d)(1)(iii) through (d)(1)(iv)(A) [Reserved]. For guidance see §86.1342–90.

(d)(1)(iv)(B) For petroleum-fueled, natural gas-fueled and liquified petroleum gas-fueled engines, HC_e is the FID measurement.

(d)(1)(iv)(C) through (d)(3)(v)(A) [Reserved]. For guidance see §86.1342–90.

(d)(3)(v)(B) CO_e = [1 − (0.01 + 0.005HCR) CO_{2e} − 0.000323R] CO_{em} for methanol-fuel, natural gas-fuel and liquified petroleum gas-fuel where HCR